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Roller Chopping for Site Preparation in Wisconsin: A Case Study

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ROLLER CHOPPING FOR SITE PREPARATION IN WISCONSIN: A CASE STUDY

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Throughout the United States, concern for wood fiber shortage has focused attention on converting poor quality hardwood stands to more productive conifers. From 1980 to the year 2000, pulpwood consumption is expected to double (U.S. Department of Agriculture Forest Service 1973).

In the Lake States, pulpwood is the dominant product (fig. 1) (Blyth *et al.* 1980). Escalating softwood stumpage prices and conifer shortages motivate land owners to convert low value, slower growing hardwoods to high value, fast growing softwoods.

To achieve optimum growth of conifers in plantations, good site preparation is essential. It has long been recognized that vegetative competition can significantly reduce the rate of survival and subsequent growth in plantations (Stone and Chase 1962). Investigators have noted that without good site preparation, plantations will normally fail if planted under the mixed aspen/hardwood overstory typically found on most conversion sites (Fox 1973, Rudolph 1950). But with good site preparation, early height growth can be increased 50 to 100 percent (Knighton 1972, Roe 1955), and volume growth can be improved by as much as 60 to 300 percent (Wittenkamp and Wilde 1964). To achieve good survival and growth of red pine on a mixed aspen/hardwood site, most competing vegetation should first be removed by harvesting all merchantable materials. Then, the site should be prepared by shearing, roller chopping, barrel scarifying, root raking, burning, and/or applying chemicals (Fox 1973, Benzie 1977, Perala 1977). Several treatments are often better than one, and chemical treatment is almost always necessary after aspen or hardwood site conversion.

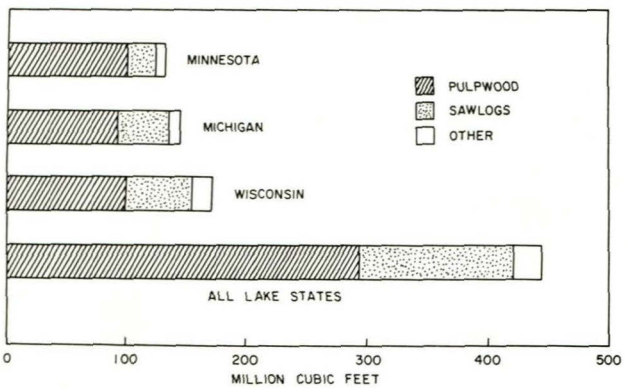

Figure 1.—*Lake States roundwood production by type of product, 1975 (Blyth* et al., *1980).*

Among the various site preparation techniques, interest in mechanical or chemical treatment of cutover areas to prepare for the planting of conifers has been increasing in the Lake States. However, production and cost data on site preparation are needed to analyze and establish economically feasible site preparation techniques. This paper presents the results of a cost and productivity study of roller chopping to prepare a cutover aspen site for conversion to red pine.

STAND DESCRIPTION

In August 1980 the Forestry Sciences Laboratory in Houghton, Michigan, in cooperation with the Champion International Corporation and Michigan Technological University, conducted a field study of the cost and effectiveness of roller chopping on 54.4 acres in Sections 9 and 10, T.37N, R.17E, Marinette County, Wisconsin. The area had been logged for aspen pulpwood about 6 months before and now consisted of a stand of small aspen and aspen sprouts averaging 3 inches d.b.h. with a basal area of 15 sq ft/acre (fig. 2). The topography was level except for a few localized knolls that had slopes up to 30 percent. The soil was sandy and dry. Future plans for the area call for additional treatments of roller chopping or herbicides during summer 1981 and planting of red pine in spring 1982.

EQUIPMENT USED

The equipment used on the project was an International TD-15C Pay Dozer pulling a Model LRC812 single drum roller chopper manufactured by the Lucas Machine and Welding Company, Inc. (fig. 3).[1]

The TD-15C Pay Dozer weighed 31,520 pounds equipped with the dozer and hydraulic control system. The machine had a 4-cycle diesel turbocharged engine, which developed 140 net flywheel horsepower at 2,500 rpm. The dozer blade, hydraulically controlled for lift, pitch, and angle, was 120 inches wide.

The roller chopper had a 5-foot o.d. drum, 8 feet wide, equipped with 12 (3/4" x 10" x 8') cutting blades equally spaced around the circumference of the drum. The drum was filled with 550 gallons of water to give the machine a total weight of 18,200 pounds.

OPERATION

The equipment operator followed a circular pattern of roller chopping by first running a strip around the perimeter of the area. Succeeding courses were chopped inside the perimeter strip in a circular or spiral pattern until the work was completed at the center of the tract.

The dozer was used to push over the standing trees in the direction of travel; the roller chopper then passed over the felled trees and logging debris on the ground, reducing the material to smaller pieces.

Figure 2.—Cutover aspen stand before roller chopping.

RESULT

In general, the machine chopped the woody material effectively. The smaller dried stumps remaining after the logging were often broomed and split by the chopper blades (fig. 4). Green stumps more than 6 inches in diameter were rarely affected (fig. 5). Bole material 3 inches in diameter or less oriented in the direction of the machine's travel was usually chopped into short pieces (fig. 6). Dry logging debris was better chopped than green wood (fig. 7).

Figure 3.—*Equipment used for roller chopping.*

[1]*Mention of trade names does not constitute endorsement of the products by the USDA Forest Service.*

Figure 4.—*Splitting and brooming of dried stump caused by roller chopping.*

Sometimes the dozer blade "scalped" the surface of the ground, exposing the bare soil. The cutting blades of the roller chopper sank several inches into the ground, severing the roots and loosening the top 4 to 8 inches of litter and soil (fig. 8). Figure 9 is an overall view of the area after roller chopping.

Figure 5.—*Solid stump more than 6 inches in diameter, little affected by roller chopping.*

Figure 6.—*Material less than 3 inches in diameter chopped into short pieces.*

The machine operated on slopes up to 25 percent but had difficulty on slopes steeper than that. On 30-percent slopes, the machine could operate well only when traveling downhill.

Productivity data are summarized as follows:

Average width of swath	8 feet
Total area chopped	54.4 acres
Total machine time	35.0 hours
Productivity	1.55 acres/hour
Average travel time when chopping	171 feet/minute
Operator time (includes travel to and from job, machine maintenance, etc.)	51 hours
Supervision	19 hours

Figure 7.—*Effect of roller chopping on 4-inch diameter dry logging debris.*

Figure 8.—*Cutting blades of roller chopper sink into ground, loosening the top 4 to 8 inches of litter and soil.*

Figure 9.—*Overall view of the area after roller chopping.*

Based on our assumptions (tables 1 and 2) and the 1980 purchase cost for the equipment, the machine costs for the TD-15C and the Lucas roller chopper were calculated as $41.63 and $2.92, respectively, per productive hour or a combined cost of $44.55 per productive hour as shown in the following tabulation:

Itemized equipment cost (1980 dollars):

Machine	Initial cost	Cost/hour (without labor)		
		Fixed	Operating	Total
1 International Bulldozer TD-15C	$104,097	$24.03	$17.60	$41.63
1 Lucas Roller Chopper 812	16,848	2.81	.11	2.92

Cost per acre is estimated as:

	Total cost	Cost/acre	Percent
Total machine cost ($44.55/hr x 35 hr)	$1,559.25	$28.66	67
Operator cost[2] ($10/hr x 51 hr)	510.00	9.38	22
Supervision[2] ($14/hr x 19 hr)	266.00	4.89	11
TOTALS	$2,335.25	$42.93	100

DISCUSSION AND RECOMMENDATIONS

The productivity of 1.55 acres/hour and cost of $42.93/acre obtained on this project are comparable to those realized in site preparation work in the southern United States. Productivity of roller chopping on Crown Zellerbach Corporation's southern clearcut site preparation projects, using crawler tractors for motive power, range from 1.3 to 1.7 acres/hour (Forest Industries 1976). Roller-chopping costs for site preparation in the northern coastal plain region average $28.11 machine cost, $9.52 labor cost, and $2.21 supervision cost/acre (Moak *et al.* 1980).

The machine operator on our study had no previous experience in roller chopping and needed more supervision than normal. As the operator gains more experience, supervision cost should be reduced and productivity increased to 1.6-1.8 acres/hour (based on chopping speed of 171 feet/minute) by minimizing turnaround and unnecessary chopping travel.

Crown Zellerbach Corporation uses a large, wheeled skidder and roller chopper on the flat areas in the South to increase the productivity of site preparation from an average of 1.5 acres/hour when using crawler tractors to 3.2 acres/hour with a skidder (Forest Industries 1976). Burns and Hebb (1972) also reported that in 15 years, planted slash pine on sites prepared by burning and double chopping grew 4 feet higher and 0.4 inch larger in d.b.h. than pine on single-chopped sites. Further study is recommended to determine the effectiveness and cost of double chopping and to see if using a large, wheeled skidder and roller chopper would increase the productivity of site preparation on flat land in the Lake States.

[2]*Labor cost assumed.*

Table 1.--Calculation of the hourly machine rate for a TD-15C International bulldozer

MACHINE RATE

Description

Manufacturer International Bulldozer Model TD-15C H.P. 140

Purchase Cost: $104,097.00

Less: Tire Cost - -

Total Initial Investment (P) $ 104,097.00

Salvage Value (S) (20 % of P) $ 20,819.00

Estimated Life (n) 5 years

Working Days/Year 250 days

Scheduled Hours/Year (SH) 2,000 SH

Utilization (U) 70 %

Productive Hours/Year (PH) 1,400 PH

Average Value of Investment (AVI) = $\frac{(P - S)(n + 1)}{2n} + S$ $ 70,786.00 /yr

II. Fixed Cost
Depreciation (D) = $\frac{P - S}{n}$ $ 16,656.00 /yr

Interest 18 %
Insurance 3 %
Taxes 3 %

Total 24 % X (AVI = $ 70,786.00 /yr) $ 16,989.00 /yr
Total fixed cost per year $ 33,645.00 /yr
Fixed cost per SH $ 16.82 /SH
Fixed cost per PH (A) * $ 24.03 /PH

III. Operating Cost
Maintenance and Repair $\frac{(100\ \% \text{ of } (P - S))}{n \times PH}$ $ 11.90 /PH

Fuel Cost $ 5.20 /PH
Oil and Lubricants $ .50 /PH
Tires = $\frac{1.15 \times \text{tire price}}{\text{Total tire life in hours (miles)}}$ $ - /PH

TOTAL OPERATING COST PER PH (B) * $ 17.60 /PH

* Machine Rate per PH (A + B) $ 41.63 /PH

Table 2.--Calculation of the hourly machine rate for a LRC 812 Lucas Machine and Welding Roller Chopper

MACHINE RATE

Description

Manufacturer Lucas Machine & Welding Model Roller Chopper LRC 812 H.P. -

Purchase Cost: $16,848.00

Less: Tire Cost - -

Total Initial Investment (P)		$ 16,848.00
Salvage Value (S)	(20 % of P)	$ 3,369.60
Estimated Life (n)	10 years	
Working Days/Year	250 days	
Scheduled Hours/Year (SH)	2,000 SH	
Utilization (U)	70 %	
Productive Hours/Year (PH)	1,400 PH	
Average Value of Investment (AVI) = $\frac{(P - S)(n + 1)}{2n} + S$		$ 10,782.72 /yr
II. Fixed Cost Depreciation (D) = $\frac{P - S}{n}$		$ 1,347.84 /yr
Interest 18 %		
Insurance 3 %		
Taxes 3 %		
Total 24 % X (AVI = $ 10,782.72 /yr)		$ 2,587.85 /yr
Total fixed cost per year		$ 3,935.69 /yr
Fixed cost per SH		$ 1.97 /SH
Fixed cost per PH	(A) *	$ 2.81 /PH
III. Operating Cost		
Maintenance and Repair	(10 % of $\frac{(P - S)}{n \times PH}$)	$ 0.10 /PH
Fuel Cost		$ - /PH
Oil and Lubricants		$ 0.01 /PH
Tires = $\frac{1.15 \times \text{tire price}}{\text{Total tire life in hours (miles)}}$		$ - /PH
TOTAL OPERATING COST PER PH	(B) *	$ 0.11 /PH
* Machine Rate per PH (A + B)		$ 2.92 /PH

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Analyzes the cost and productivity of roller chopping in preparing a cutover aspen stand for conifer conversion (1.55 acres/hour at $43/acre).

KEY WORDS: Mechanical site preparation, stand conversion, aspen, red pine.

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